insolation and of effective outward radiation. The instruments used are to be adjusted to standard apparatus. Suggestions for carrying out such measurements will be specially prepared.

4. Attention is called to the value of measurements of clearness of air, color of sky, anomalous refraction (measurements of the dip of the horizon), twilight, earthlight (Nachtschein), and zodiacal light. Details on the methods of these measurements have been drawn up by Professor Maurer (Zurich) and Dr. F. Schmid (Oberhelfenswil, Switzerland).

5. Special instructions on eye observations of the quantity and character of opalescent turbidity will be drawn up by Doctor Bergeron (Oslo).

6. As the value of the radiation constant there is recommended

$$\sigma = 8.26 \cdot 10^{-11} \cdot \text{cal/cm}^2 \cdot T^4$$
$$(5.76 \cdot 10^{-12} \cdot \text{watt/cm}^2 \cdot T^4).$$

In conclusion Herr Mörikofer reported his experiences in the gaging of cadmium cells and the advantages presented by taking into consideration relations of measurements with and without the employment of Minos glass (as a filter). Later, Herr Kühl presented curves from his new recording filtered potassium cell.

On Thursday, February 26, from 5:30 to 7 p. m. there was discussion of the methods of measurements with the cadmium cell; those taking part were Messrs. Büttner, Dubois, Feussner, Kühl, Mörikofer, and Süring.

(Signed) A. ÅNGSTRÖM.
R. SÜRING.
K. BÜTTNER.

## FLYING WEATHER IN THE CORPUS CHRISTI AREA

By J. P. MCAULIFFE

[Weather Bureau Office, Corpus Christi, Tex.]

The "Corpus Christi area" as usually referred to by aviators in this section extends roughly from Beeville, 56 miles north, to Kingsville, 40 miles south, and George West, 70 miles west. In this small area there is considerable diversity of weather, usually effecting visibility and ceiling.

There are three elements most vitally effecting flying in this area, namely: Fog, wind velocity, and thunderstorms. These three handicaps to flying should be carefully studied by aviators in this area.

Records at the Corpus Christi Weather Bureau show that during the 44-year period, 1887–1930, inclusive, the average number of dense fogs has been as follows during the months indicated:

| Month | Number of dense fogs | Month | Number of dense fogs |
|---|---|---|---|
| January | 3 | October | 1 |
| February | 2 | November | 2 |
| March | 2 | December | 3 |
| April | 1 | | |

During the other months of the year fog occurs so seldom that it is practically negligible.

A peculiar condition exists at Beeville. Fogs are much more frequent there, and within 5 to 10 miles each side, than they are at Corpus Christi. Many mornings when Corpus Christi and San Antonio report perfect visibility and ceiling, aviators run into dense fog at Beeville. Of course with weather reports from San Antonio and Corpus Christi at hand they fly high and soon come out into clear weather. Occasionally aviators have left Corpus Christi without first getting weather data, and in many of these cases they were forced to turn back when near Beeville, not attempting to fly farther, because they assumed that the fog continued northward.

The cause of these frequent fogs in the vicinity of Beeville seems to be due to the slope of the land eastward to the Gulf, the presence of San Antonio and Copano Bays that indent the coast line sharply in the latitude of Beeville, and probably also the Aransas River that flows past Beeville. These lowlands and water areas here cause air currents from the Gulf to flow westward, meeting the cold interior air, and causing fogs. In thickness and their local character these fogs resemble the mists and fogs of the eastern mountain regions. The frequency of these fogs leaves no doubt that a sharp temperature gradient exists in that locality, especially in the winter months. These fogs are not confined to any particular type of weather, but occur with high pressure, as well as when the barometer is low. They dissipate usually about 10 a. m., but occasionally persist until noon or the midafternoon. The average thickness of these fogs is 1,000 feet.

The second great handicap to safe flying is the wind velocity on this coast.

The writer's attention was first directed to the erratic wind velocities in this section by a letter from one of the officials of the T. A. T. Corporation. In his letter the official mentioned the fact that reports from San Antonio were frequently misleading, because the weather was subject to such erratic changes near Kingsville. He mentioned strong head winds as one of the annoying elements. This would be, of course, a strong southeast or south wind for the planes that were coming from San Antonio. The prevalence of these winds caused a readjustment of schedules by the T. A. T. It was noticed that the planes would enter these windy regions suddenly from a region that had given only moderate southerly breezes, and this windy condition almost invariably occurred within 10 miles of Kingsville. (The planes usually traveled on a course from San Antonio to Brownsville about 50 to 75 miles inland.) This strong wind that the planes encountered at this locality is the celebrated Corpus Christi sea breeze (1) that is always present when some atmospheric disturbance does not interfere with it. It extends for only a short distance inland, and for this reason is encountered only when near the Gulf waters. Kingsville is very close to Baffins Bay, a long narrow bay that extends westward from the Gulf for 30 or 40 miles. The sea breeze on this coast extends to a height exceeding 1,000 feet, and probably as high as as 2,000 feet, as observed by ceiling balloons and the movement of cumulus clouds. The sea breeze in the vicinity of Kingsville has about the same strength as at Corpus Christi and averages 16 to 25 miles per hour. Sometimes it reaches 30 miles per hour.

This annoyance can be avoided, somewhat, by aviators either going far inland and avoiding Kingsville, or swinging Gulfward north of Corpus Christi. The wind velocities are not so great on the Gulf beaches as they are on the shores of the bays. The sea breeze also causes another peculiar atmospheric irregularity, thunderstorms that are difficult to forecast.

From direct observation at Corpus Christi it has been found that thunderstorms occur two or three times more frequently at Robstown, 14 miles westward, than they

do at Corpus Christi. These storms can be seen forming during summer afternoons and sometimes the thunder can be plainly heard at Corpus Christi, while the sky is clear from the Gulf horizon to within 5 or 6 miles of Robstown. It is reported that this same condition occurs at Kingsville. The reason is, of course, convection. The swiftly moving sea breeze prevents the formation of these thunderstorms (2) near the bays, but just as soom as this breeze ceases convectional thunderstorms occur, just as they do in any interior section. Occasionally these storms cause hail, and generally dangerous squalls, so aviators are careful in this area to avoid them. They can easily be avoided by airplanes flying as close to the Gulf as possible, and this is generally the course advised during summer by all planes flying in this area. Sometimes the planes coming from San Antonio or Brownsville are caught unawares, and have to encounter these storms, but with available reports of storms prevailing in the interior, with clear sky near the coast, it is easy for pilots to steer a course that will avoid these dangerous phenomena. The severity of the coastal storms has been discounted by some writers who have witnessed thunderstorms in the Mississippi Valley or other interior regions. However, it should be remembered that while these thunderstorms are rather quiet, with the thunder generally high, they are very dangerous to airplanes, because they have very strong upward currents, erratic squall conditions, and often hail. As an illustration of the dangerous type of these coast storms, two incidents are cited here:

On the occasion of an aerocade in 1929 the Weather Bureau at Corpus Christi and Brownsville furnished information at intervals of two hours during the progress of the flight from Houston to Brownsville. At 1 p. m. the planes left Corpus Christi for Brownsville, with clear weather at Corpus Christi, and overcast at Brownsville. There had been a few thunderstoms during the morning. Near Kingsville the planes encountered rain; farther south thunderstorms were seen. All but 2 of the 24 planes turned back and returned to Corpus Christi. One of the planes that continued reached Brownsville safely, the other one was blown off its course, and landed in a desolate spot in Mexico 100 miles south of Brownsville.

The other case of note was a 4-passenger plan returning to Kansas City from Aransas Pass, 24 miles east of Corpus Christi. The weather forecast issued that morning from the Corpus Christi office was for local thundershowers. The pilot received this forecast by telephone from the local office, but nevertheless took off for his homeward flight. Within 10 minutes after the start he encountered a thunderstorm, attempted to fly through it, and crashed, killing all the occupants of the plane. This thunderstorm was one without much thunder, but from evidence obtained after the crash the plane was carried upward several thousand feet and dropped on the other side.

### CONCLUSIONS

From the above stated facts it is seen that flying weather in the Corpus Christi area is practically uninterrupted during the five months, May to September, inclusive, in so far as the greatest hazard to flying is concerned—fog. During the other months of the year the elements to be watched are the strong and erratic winds on this coast, and thunderstorms.

Wet "northers" are also a great handicap to planes traveling northward. When they prevail the ceiling is low, sometimes below 700 feet and occasionally 500 feet. Careful pilots in this area generally ground their planes when one of these annoying "northers" is expected. On the average about three to five such disturbances will occur in each month, November to March, inclusive.

(1) Heckathorn, Charles E. MONTHLY WEATHER REVIEW, June, 1919, pp. 413–415 Land and Sea Breezes in the Vicinity of Corpus Christi.

(2) Tannehill, Ivan H. MONTHLY WEATHER REVIEW, Sept., 1921, pp. 498–499, Wind Velocity and Rain Frequency on the South Texas Coast.

## PILOT-BALLOON OBSERVATIONS AT HAVRE, MONT.

By FRANK A. MATH

[Weather Bureau Office, Havre, Mont.]

Although numerous compilations of balloon and kite data have been published in the MONTHLY WEATHER REVIEW, it was thought that some of the more or less interesting results obtained with pilot balloons at Havre, Mont., during a period of three years and five months would add another chapter for study.

Whenever permissible, two balloon ascensions are made daily. The hours of observation were 6 a. m. and 2 p. m. from the beginning, August 6, 1927, to March 31, 1930, after which the hours were changed to 4.30 a. m. and 4.30 p. m. to work simultaneously with other stations. While a total of 2,487 observations were possible, at two a day, during the period from August 6, 1927, to December 31, 1930, there were 2,392, or 96 per cent, actually made. The visibility recorded with each according to the scale, 0 to 9, as given on page 29, Instructions for Making Pilot Balloon Observations, was as follows:

| Observations | Visibility | Percentage |
|---|---|---|
| 1,149 | 9 | 48 |
| 658 | 8 | 27 |
| 337 | 7 | 14 |
| 119 | 6 | 5 |
| 61 | 5 | 3 |
| 57 | 4 | 2 |
| 11 | 3 | 1 |

This indicates a high per cent of the number of possible ascensions and, as a rule, good visibility, over the plains of central Montana. A further indication of good flying weather is the small number, 95 "no ascensions" in three years and five months, or less than 4 per cent of total possible. Snow was the cause of preventing 48 of these "no ascensions"; rain, 26; low clouds, 10; fog, 8; high wind, 2; smoke, 1. In this connection it may be said that occasionally during low temperature in winter, a light dry snow falls with visibility 5 or 6. At such times balloons can be observed to altitude 1,000 to 2,000 meters.

There were 773 balloons reached an altitude of 4,000 meters or higher, 42 reached 10 kilometers (6.2 miles) or higher; and 13 reached 11 kilometers. The longest time that any one balloon was observed was one hour and 25 minutes, reaching an altitude of 15,390 meters (9.4 miles) on March 15, 1929, the highest of record for this station. The highest velocity computed from any balloon observation was 45.3 meters per second (101 miles per hour) on December 24, 1929. One of the balloons was observed to a distance of 44,600 meters (27.7 miles) away from Havre. That was the farthest of record by observation.

The bottoms of the paper lanterns attached to the balloons during darkness are stamped with the name of